NASA Energy Management Program Stakeholder Workshop
March 29, 2007, 9:00 a.m. - 4:00 p.m.
Battelle, 2101 Wilson Blvd, Suite 800, Arlington, VA
Summary Report

Attendees

Name	Affiliation
Stakeholders	
Ken Andrasko	EPA
John Ferrell	DOE Office of Bioenergy Program
Mike Sale	ORNL
Rob Homer	NewEnergy Associates
Patrick Walshe	TVA
Wayne Moodie	PJM
Ken Huber	PJM
Scott Sklar	Stella Group
Bob Smith	DOE EIA
Organizers, Advisory Committee Members, Observers	
Rich Eckman	NASA Energy Management Program
Paul Stackhouse	NASA Energy Management Program
Lucien Cox	NASA Cross-Cutting Solutions Program
Robin Graham	ORNL
Gene Fosnight	SAIC (onsite at USGS EROS)
Dave Renne	NREL
Jill Engel-Cox	Battelle
Erica Zell	Battelle

Proceedings

I. Workshop Purpose and Summary

   A. Purpose
The purpose of the NASA Energy Management Stakeholder Workshop was to make a stronger connection between the NASA Energy Management Program and energy sector stakeholders, particularly those focused on renewable energy and electric load forecasting. The workshop was designed to reach out to stakeholders in the energy sector to understand their current activities, decision-support systems, and data needs. Further, the workshop was designed to inform energy stakeholders of the current activities and product offerings of the NASA Energy Management Program, and to identify the areas of highest potential and potential partners for new or expanded collaborative projects.

   B. Summary of Results
Several common themes emerged throughout the Stakeholder Workshop. These themes emerged across the discussions of major energy sources (wind, solar, hydro, bio, ocean, geothermal, and fossil) and electric grid operations.

➢ **Stakeholders identified very specific spatial and temporal needs for data.** For example, some requested gridded data while others requested regional and local information, such as climate forecast information for long-term planning. Some stakeholders requested near real-time data and other requested historical data.

➢ **Stakeholders expressed a strong interest in forecasts.** For example, stakeholders were interested in generalized hourly forecasts of wind generation for grid integration, and forecasts of temperatures and extreme weather events for load forecasting.

➢ **Stakeholders identified the need to integrate different data sets.** For example, stakeholders need to integrate data sets gathered by various agencies with NASA data, or integrate data sets across different energy types.

➢ **Stakeholders identified the need for user-friendly applicable tools and an organized search and filter capability to access NASA data and products.** Stakeholders indicated a need to bridge the gap between those familiar with the satellite data and those working in the energy and environmental sectors.

➢ **Stakeholders identified the need to present data to financial institutions and feed NASA data into economic models.** For example, the financiers of renewable energy projects need transparent information in graphical and map-oriented formats, and electric grid markets and long-term planning rely heavily on economic models and information.

➢ **Stakeholders expressed interest in visualization of complex data and pattern recognition.** For example, operation of the grid involves massive amounts of data and requires high-performance computing (HPC), but must result in decisions made on a quick time scale.

➢ **Stakeholders identified a need for pilot projects that engage the right range of partners across the public and private sectors.** Potential types of partners were suggested for a range of topics including hydropower, biomass, and load forecasting.

II. Presentations

A. Satellites 101 for Energy Applications (Erica Zell & Jill Engel-Cox, Battelle)

This presentation covered satellite terminology, data products, energy examples, and limitations of satellite data.

B. NASA Energy Management Program Summary (Rich Eckman & Paul Stackhouse, NASA)

This presentation covered current projects and partnerships of the NASA Energy Management program, program priorities, and information on working with NASA.

In discussion afterwards, one stakeholder noted that forecasting of electric output from wind generation facilities is becoming increasingly important. Another stakeholder noted that the Shuttle Radar Topography Mission (SRTM) is an important data source for hydropower. Another stakeholder stated that they would like to see a user-friendly catalog or system that allows users to query to get an answer on what accessible tools can serve the user's needs, moving from a large array of sensors and data sets to applicable results.

Lucien Cox, the NASA Cross-Cutting Solutions Program Manager, also provided the following information. The NASA Cross Cutting Solutions Program is designed to bring NASA research results together to see what combinations of models and results can benefit a user's program. The Cross Cutting Solutions Program provides options and a demonstration on how a user's needs may be served and then works iteratively with a user to refine the solution.

C. Accessing NASA Data (Robin Graham, Oak Ridge National Laboratory [ORNL], Manager ORNL DAAC)

This presentation covered the NASA Distributed Active Archive Centers (DAACs) and other NASA websites, the ORNL DAAC, and specific resources that may be useful for hydropower and bioenergy.

D. National Renewable Energy Laboratory (NREL) Activities and Energy Policy Act Reports (Dave Renne, NREL)

This presentation covered activities at NREL with relevance to NASA resources, and reports prepared by NREL under the Energy Policy Act (see http://www.oe.energy.gov/energy_policy_act.htm).

III. Stakeholder Discussion

Stakeholders were asked to provide descriptions of their activities, decision support tools, and data needs (fulfilled or not).

Ken Andrasko, EPA- Ken is with the EPA Office of Air and Radiation, Climate Change Division. In terms of bioenergy, the office focuses on the environmental and cost implications of bioenergy initiatives. The office examines the alternatives of bio-generated liquid and solid fuels in the context of other competing climate change options (e.g., forest and agricultural management options). They are interested in a broad range of environmental implications including water quality, air quality, and nutrient and pesticide implications. They are also interested in trying to improve the way biofuels are characterized in models from a regional to global scale.

John Ferrell, DOE Office of Bioenergy Program- John's office commissioned the billion ton study (Biomass as Feedstock for a Bioenergy and Bioproducts Industry: The Technical Feasibility of a Billion Ton Annual Supply, April 2005, http://www1.eere.energy.gov/biomass/pdfs/final_billionton_vision_report2.pdf) with the U.S. Department of Agriculture. The study highlights sustainability issues. For example, what level of residue removal is sustainable, what is the corn yield potential, and what will be the efficiency of biorefinery technologies? What is the resource base? Also, what would bio energy do to soil carbon and temperature? Information needs to be overlaid in a database to answer these questions. Can NASA data help answer these questions, and help answer the questions of bio refinery developers? We need to look at the next 5, 20, and 50 years.

Mike Sale, ORNL- Mike is in the Applied Science and Technology group at ORNL. He works on a number of different issues including hydropower, bioenergy, and climate change. He is also working on the water energy nexus, adding climate variability to hydropower models. Hydropower output can vary by about 30% per year. They work with the Federal Energy Regulatory Commission (FERC) on modeling hydropower, and could use better information and models (e.g., soil moisture, evaporation, rainfall, reservoir, water temperature, water quality). They need cross cutting tools to combine different areas. There has been a push to restore

hydropower budgets at DOE to include wave and ocean power. NASA products such as those from TOPEX/Poseidon have been used for wave power. Thermal effects in rivers that are used for cooling water is also an issue and may require higher resolution data.

Rob Homer, NewEnergy Associates- NewEnergy develops models for utility forecasting and planning, for customers such as electric utilities, the natural gas industry, and independent system operators. He is involved with Nostradamus, a short-term load forecasting tool. His interest is to see if NASA data is usable in their products, can be made accessible to customers, and provides enough improvement to justify the research investment. Nostradamus can use a wide variety of parameters and typically uses temperature, relative humidity, and wind speed.

Patrick Walshe, TVA- Patrick is the primary load forecaster for Tennessee Valley Authority (TVA). His forecasts cover part or all of six states. He uses proprietary neural net models and their derivatives. The data input includes temperature, dew point, cloud cover, and precipitation. TVA is vertically integrated. Storms in the summertime can cause sudden load changes that are difficult to predict. Improved 12- to 36-hour forecasts would be helpful. For long-term asset planning, climate change is an unknown. They are trying to normalize climatological data in light of recent climate warming.

Wayne Moodie, PJM- Wayne works at PJM Interconnection and is responsible for a seven-day abode forecast on a daily basis for seven areas based on 19 weather sites. He uses historical load and historical temperature along with forecast temperature, run through proprietary models and their derivatives. They get an error on their 24-hour forecasts of about 2.1% to 2.9%. They are looking to improve their weather forecast tool -- they currently do not use cloud cover and humidity because they find it reduces accuracy. They also have problems with periods of dynamic weather, and also getting erroneous data. They do not factor in any urban heat island effect.

Ken Huber, PJM- Ken works at PJM Interconnection which is the world's largest electric grid control system, controlling the grid in the Northeast and Mid-Atlantic. PJM does not own assets but rather controls the grid for reliability and runs a market. Ken looks at advanced technologies such as visualization and new decision-support tools that may be used to make decisions by dispatchers. They deal with large amounts of information -- 100 generators with six major parameters, 200 tie lines with three major parameters -- and they need to make decisions on a very quick timescale. For load forecasting, they have an interchange where people can buy and sell in near real-time, changing the system load quickly. They are involved with Smart Grid to send cost signals to all participants, and are looking at high performance computing.

Scott Sklar, Stella Group- Scott's clients are state and local government looking to expand energy use, large facilities, and other government or private clients looking for their own power sources who need information about the best options. His clients do not have a lot of faith in models, and would like user-friendly transparent information, in graphical and map-oriented formats. He has interests in solar and wind power along with some biomass and micro hydropower. He uses a private consulting company for information on solar, wind, and hydropower, although they do not have biomass data. For the most part the data cannot be combined and is not user-friendly. Aggregating some of this data with NASA data may make sense.

Bob Smith, DOE EIA- Bob Smith works in the U.S. Department of Energy, Energy Information Administration (EIA). He works on forecasting renewable energy on an annual basis out to 2030

with the National Energy Modeling System (NEMS). This includes solar power and wind power (including offshore wind). Additional interest has been drawn to renewable energy due to state Renewable Portfolio Standards and the potential for carbon caps. EIA would like to expand and update their sources. For example, geothermal energy is forecasted with data that is 20 years old. They have also seen recent climate variation such as changing precipitation and snowmelt in the West, and would be interested in NASA input on incorporating climate trends into NEMS.

Gene Fosnight, SAIC (onsite at USGS EROS)- Gene works at the U.S. Geologic Survey Earth Resource Observation Systems (EROS) Data Center. They have a good database of solar and wind resources, although they are difficult to use. NASA is currently funding enhancements to the decision-support system Solar and Wind Energy Resource Assessment (SWERA) to make it more client-centric. They are adding global data sets to pass through seamlessly to the decision-support system, and primarily targeting the developing world. They are planning to go global for areas without high resolution data, and looking at hydropower using vegetation, rainfall (Tropical Rainfall Measuring Mission, TRMM), and stream flow data.

IV. Subsector Focus Groups Breakout Group

A. Renewable Energy
John Ferrell (U.S. Department of Energy)
Mike Sale (Oak Ridge National Laboratory)
Scott Sklar (Stella Group)
Ken Huber (PJM Interconnection)
Bob Smith (Energy Information Administration)
Gene Fosnight (U.S. Geological Survey)
Facilitator/Note taker: Jill Engel-Cox (Battelle)
NASA Observer: Paul Stackhouse
Observer: Robin Graham (ORNL)

Although originally intended to focus on renewable energy, this group agreed to broaden their scope to production issues for both renewable and traditional energy sources. The following is a summary of the responses to the five charge questions:

1. **What are the key issues that are currently dominating the topic area? What emerging or future concerns (out 5 years) are likely to take high priority?**

    - A key issue for wind power siting and operations is forecasting in order to schedule generation being put on the grid.
    - A key issue for plug-in hybrids and distributed generation is the amount of power they will send to the grid (e.g., smart batteries with battery banks).
    - Thermal cooling for electric power plants will become a bigger issue as surface water temperatures increase.
    - For biomass, the cost of production (fuel, infrastructure, transportation) and also the sustainability and size of the overall biomass resource are key issues.
    - Climate change is a key issue, especially considerations such as land use, temperature, and reducing uncertainties in the forecast to enable adoption and mitigation.
    - New geothermal data is needed on the potential, extent, depth, and definition of the resource.

- Integrating data sets and energy types is a key issue for hybrid production and optimizing the energy portfolio.
- Managing risk is the key issue for resource management in many dimensions (e.g., water, the environment, food, and national security).
- Better resource data is needed on wave height and deep currents to assess the energy potential.
- Extreme weather prediction is a key issue (e.g., droughts, El Niño, etc.).
- Siting infrastructure (e.g., transmission corridors or gas pipelines) based on resource data such as the location of biofuel resources and refineries is a key issue.
- Water storage is a key issue, and time series records are needed of snow, ice, and reservoirs to show trends. There are also links to water management for topics such as irrigation and biofuels.

2. **What current decision-support systems are used? Who are the developers, operators, and end-users?**

- Models at Federal agencies (including NEMS at EIA)
- Regulations
- There are a variety of biomass decision support systems that are being developed and used piecemeal (e.g., Polysis).
- Financial and risk models for new technologies -- resource maps, geospatial information, infrastructure. Biomass and other renewable energy sources are dynamic while models are static.
- Hydropower decision-support systems are river basin models, RiverWare, Vista (BPA)- these models are monthly down to hourly.
- There are no significant existing decision-support systems for tidal and wave energy.
- Asset siting uses a variety of resource maps. New requirements may change if carbon dioxide is regulated.
- Selection of new capacity is done by bidding and risk and cost models.
- Renewable portfolio standards are set by politics without any link to resources.
- There is a need for pattern recognition to review massive amounts of data -- this requires high performance computing (HPC) and consideration of presentation to the end-user.

3. **What are the data needs and data sources of those decision-support systems?**
4. **What challenges or shortcomings in data are faced? Which of these may be filled with NASA data and products?** (responses to these 2 questions were combined, with a major focus on data needs)

- Data on currents and waves such as the amount, location, and variability are needed.
- Biomass data on urban, manure, and biowaste such as the current volume and location, along with economic data, are needed.
- Geothermal data on locations, economics, depth, and quality are needed with good documentation.
- Future climatological data (i.e., predictive) are needed. This includes temperature and water availability, trends and extremes, seasonality, moisture, and probability of events. This data is needed at specific local and regional levels for comparison with other areas.
- NASA data can help validate information on a regional scale.

- There is a need for value added products in addition to data, requiring partnership.
- For hydropower, pilot studies are needed to investigate potential data such as elevation, snow pack, soil moisture, rainfall, and discharge data. Hybrid information combining different data sets is needed, and information is needed in real-time.

5. **What types of partners should NASA engage in a pilot project to test NASA data applications?**

- There is a need for pilot projects to test data sets -- partnerships between NASA and energy sector experts.
- Cross cutting projects related to water and NASA rapid prototyping projects are needed.
- US Army Corps of Engineers (districts) are major dam operators and would like to consider climate change in their operating plans but require data, models, and guidance.
- There is a need to transform the output of global climate change models into a format that can be input into local models. NASA Langley Research Center is participating in efforts to analyze large ensemble climate sensitivity forecasts, currently on a global scale.
- There is a need for partners to link and transform NASA data as an input to economic models. This conversion can be done as a partnership between the end-user and NASA. Operational partners are needed such as DOE, EPA, NOAA, and USGS.
- Other potential partners include the Electric Power Research Institute, private groups, trade organizations, Tennessee Valley Authority, Bonneville Power Administration, and the American Public Power Association.
- NASA should engage with EIA to provide them data. However, many of the required data sets are economic in nature and dependent upon 3rd party research to create those data using the type of environmental data NASA can provide.

B. Load Forecasting
Patrick Walsh (Tennessee Valley Authority)
Rob Homer (NewEnergy)
Wayne Moodie (PJM Interconnection)
Facilitator/Note taker: Erica Zell (Battelle)
NASA Observer: Rich Eckman
Observer: Dave Renne (NREL)

1. **What are the key issues that are currently dominating the topic area? What emerging or future concerns (out 5 years) are likely to take high priority?**

One major current issue in load forecasting is accuracy. Accuracy translates into dollars for utilities and other market players. Current accuracy varies with location and how far out the forecast extends. For extreme weather accuracy is lower.

Accurate weather forecasts are a related major current issue. Currently 24-hour forecasts are in the range of 1.95° to 2.2° off. There are about 10 to 20 private weather value added data providers. Weather forecast data is needed which means NASA may have to partner with value added weather providers.

Data and model maintenance is another major current issue. A continuous stream of accurate data is needed. Value added providers sell "clean" data that has erroneous or unrepresentative historical values stripped out.

A major emerging issue is climate change which affects long-term planning, decisions on capacity, and how to use climate normals. Climate change also shifts the shoulder months (fall and spring) and effects maintenance.

Another major emerging issue is the need to forecast wind generation. One stakeholder is faced with accepting any wind power that is generated, and therefore needs to better anticipate wind generation for the day-before unit dispatch. A generalized hourly average forecast would be a good start, although stakeholders expect a 10 to 20% error. Pacific Gas and Electric in California uses operational wind forecasts, and private vendors are also doing wind forecasts (e.g., 3Tier).

2. **What current decision-support systems are used? Who are the developers, operators, and end-users?**

A variety of decision-support systems are being used including private neural net models (e.g., New Energy Nostradamus and EPRI Artificial Neural Network Short-term Load Forecaster, ANNSTLF). Some forecasters are also using a combination of models along with in-house techniques. There are about five neural net models and also there are statistical packages. The developers are private companies. The operators are utilities or interconnection organizations. The end-users can be utilities, retail marketers, or other customers.

3. **What are the data needs and data sources of those decision-support systems?**

Common inputs are historical load and historical temperature, along with forecasted temperature. Some models also include wind speed, humidity, precipitation, cloud cover, and light intensity. Various inputs can be tried to train a neural net with different weightings to see if the resulting load forecasts are improved. There are varying levels of sophistication in the models and techniques utilized.

Information on true population and industry density is also needed to weight load for some forecasting techniques. Other models can accept multiple gridded temperatures, as different models have different configurations to accept multiple inputs. It was suggested that NASA Marshall has a project related to urban population and urban heat. Also the Socioeconomic and Data Applications Center (SEDAC) and Oak Ridge National Laboratory (ORNL) DAACs may have useful information on this topic.

4. **What challenges or shortcomings in data are faced? Which of these may be filled with NASA data and products?**

One major challenge in working with NASA data is the time that it takes to process and transmit or post the data. In general the data needs to be collected and ready within one hour, although information on cloud cover may be useful within a few hours.

Information on long-term precipitation patterns would be useful for climate change models that look five to 30 years into the future. For example this may be helpful for TVA hydropower. Two potential NASA projects suggested were those at Goddard Institute for Space Studies.

Another major consideration on working with NASA was that after several years the "research" data collected by NASA may come to an end, leaving those that rely on it empty-handed. Another stakeholder noted that this is a big challenge, the lack of continuity between NASA and NOAA.

Another consideration on working with NASA is not infringing on the private sector, i.e., taking over functions that are already performed by private companies.

Stakeholders also expressed frustration in trying to navigate data and web sites produced by NASA. The need for a bridge between those familiar with satellite data and those familiar with energy and environmental science was identified. Stakeholders requested a common portal that allows those with little satellite experience to access data.

5. What types of partners should NASA engage in a pilot project to test NASA data applications?

One potential partner is private weather vendors of which there are about 10 to 14. Care would need to be taken to help them improve their forecasts without infringing on their current business. Private weather vendors are listed in the American Meteorological Society bulletin.

Private sector companies such as 3Tier would be good partners as solar and wind forecasts are evolving quickly.

Forensic meteorologists may have uses for NASA data.

Other potential partners listed include NOAA, electric utilities, and load forecast model builders.

Google is looking to populate their Google Earth site with "cool" data sets. There may be intellectual-property questions. Google has resources to handle data, searching, and filtering.

One stakeholder noted that NASA data has value when combined with other data sets, and that those partners need to be identified. For example, commercial remote-sensing or European Space Agency Meteosat data for real-time solar information.

V. Discussions and Conclusions

A. What conferences, meetings, publications, or venues should the NASA Energy Management Program participate in to become more engaged with the energy sector?

Trade associations and resource associations mentioned include municipal water associations and municipal solid waste associations. Many trade groups are located in Washington, DC, and convene "data people" on a regular basis. Also, data collectors (from the private sector) that come to trade shows may be interested in NASA data.

For hydropower, the National Hydropower Association, Water Power, Hydrovision, and HCI are relevant groups and publications.

Financial institutions and project financiers may be interested in decision-support tools as these are not well known to the financial community. There are 60 to 80 companies that would come to a seminar if NASA invited them. These organizations need information portrayed differently than scientists do. Scott Sklar offered to provide a list.

The Renewable Fuels Association has several conferences in the coming months that are relevant, including one on fuels and one on management, policy, and technology. For biotechnology, Bio has an annual symposium and there is a Biomass Research and Development Board that involves a number of Federal agencies. John Ferrell offered to provide a contact for this.

One stakeholder suggested that the Recommendations Report prepared by Battelle should not be converted into a journal article. One stakeholder suggested breaking pieces of the report into sector specific publications such as HCI publications for hydropower. Another stakeholder suggested focusing on user-friendly tools.

One stakeholder suggested jointly sponsoring a graduate program to identify and train university Ph.D. students. Lucien Cox noted that the NASA Cross Cutting Program also manages the Human Capital Development program.

B. Identify other potential stakeholders/groups to be contacted or represented in future NASA Energy Management Stakeholder Workshops.

We asked participants to send this information to the workshop organizers via e-mail following the workshop, however we did not receive any input.

C. Workshop Conclusions, Future Program Directions and Opportunities

Rich Eckman thanked everyone for coming and providing useful input. He also discussed the current NASA ROSES solicitation for the Applied Sciences Program, with proposals due May 25, 2007, (http://nspires.nasaprs.com/external/viewrepositorydocument/77812/ROSES2007.pdf) and noted that there will likely be similar solicitations in future years.